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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/016,693	10/30/2001	Michael D. Lammert	12-1233	2474
27160 7590 01/26/2007 PATENT ADMINISTRATOR KATTEN MUCHIN ROSENMAN LLP 1025 THOMAS JEFFERSON STREET, N.W. EAST LOBBY: SUITE 700 WASHINGTON, DC 20007-5201			EXAMINER MALDONADO, JULIO J	
			ART UNIT 2823	PAPER NUMBER
SHORTENED STATUTORY PERIOD OF RESPONSE		MAIL DATE	DELIVERY MODE	
3 MONTHS		01/26/2007	PAPER	

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

Office Action Summary	Application No.	Applicant(s)	
	10/016,693	LAMMERT, MICHAEL D.	
	Examiner	Art Unit	
	Julio J. Maldonado	2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 13 December 2006.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-24 is/are pending in the application.
- 4a) Of the above claim(s) 13-24 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-12 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 12/13/2006 has been entered.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. Claims 1 and 3 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. In reference to claims 1 and 3, Applicants recite, "...said polymer selected to enable etching without the need for an etch barrier". However, there is no support in the disclosed specification of this recitation. Any negative limitation or exclusionary proviso must have basis in the original disclosure. If alternative elements are positively recited in the specification, they may be explicitly excluded in the claims. See *In re Johnson*, 558 F.2d 1008, 1019, 194 USPQ 187, 196

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(CCPA 1977) ("[the] specification, having described the whole, necessarily described the part remaining."). See also *Ex parte Grasselli*, 231 USPQ 393 (Bd. App. 1983), *aff'd mem.*, 738 F.2d 453 (Fed. Cir. 1984). The mere absence of a positive recitation is not basis for an exclusion. See MPEP 2173.05(i).

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claims 1 and 2 are rejected under 35 U.S.C. 103(a) as being unpatentable over Brighton et al. (U.S. 5,132,775) in view of Rhodes et al. (U.S. 4,536,951) and Wolf (Silicon Processing for the VLSI Era, Volume 2: Process Integration).

Brighton et al. (Figs.1-6) teach a method of forming interconnects including providing a semiconductor device (10) having a lower level layer including insulation layers (column 5, lines 3 – 10); forming a seed layer (22) on top of said lower level layer; forming a lower metal layer (12) on said seed layer (22); forming one pair of spaced apart vias (28) from a photoresist (26) on said lower metal layer (12); plating said spaced apart vias (28) defining plated pillars (16); removing the seed layer (22) not under the lower metal layer (12); forming on said one or more plated pillars and said seed layer with a dielectric layer (42) which can be planarized to expose said top surfaces of said plated pillars (column 4, lines 46 – 68); and forming a metal layer (44)

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to contact said exposed top surfaces of said plated pillars (16) (column 2, line 66 – column 6, line 19).

Brighton et al. fail to expressly disclose wherein said polymer is selected to enable etching without the need for an etch barrier. However, this is inherent because Brighton et al. do not disclose using etch barrier layer to expose said plated pillars.

Brighton et al. fail to disclose wherein said dielectric material is a low dielectric polymer coated and cured on said one or more plated pillars and seed layer. However, Rhodes et al. (Figs.1-5) teach a method of forming a layered structure including the steps of forming a lower metal layer (2) on a surface of a substrate (4); forming an upper metal layer (8) on said lower metal layer (2); and forming on said lower metal layer (2) and said upper metal layer (8) a polyimide layer (12), wherein said forming further includes coating and curing said polyimide (12), wherein the metal layers are selected from the group including aluminum and copper (column 2, line 61 – column 3, line 50).

Furthermore, according to Wolf (Silicon Processing for the VLSI Era, Volume 2: Process Integration, pages 214 and 215) polyimides are well-known material used as planarizing interlevel dielectric layers because it can tolerate high temperatures without degradation, low dielectric constant and are free of pinholes and cracks.

Therefore, It would have been within the scope of one of ordinary skill in the art to combine the teachings of Brighton et al. and Rhodes et al. to enable forming the dielectric layer in Brighton et al. according to the teachings of Rhodes because one of ordinary skill in the art at the time the invention was made would have been motivated

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to look to alternative suitable methods of forming the dielectric layer of Brighton et al. and art recognized suitability for an intended purpose has been recognized to be motivation to combine. MPEP 2144.07.

6. Claims 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Brighton et al. (U.S. 5,132,775) in view of Rhodes et al. (U.S. 4,536,951), Wolf (Silicon Processing for the VLSI Era, Volume 2: Process Integration) and Lee et al. (U.S. 6,800,928 B1).

Brighton et al. (Figs.1-6) teach a method of forming interconnects including providing a semiconductor device (10) having a lower level layer including insulation layers (column 5, lines 3 – 10); forming a seed layer (22) on top of said lower level layer; forming a lower metal layer (12) on said seed layer (22); forming one pair of spaced apart vias (28) from a photoresist (26) on said lower metal layer (12); plating said spaced apart vias (28) defining plated pillars (16); removing the seed layer (22) not under the lower metal layer (12); forming on said one or more plated pillars and said seed layer with a dielectric layer (42) which can be planarized to expose said top surfaces of said plated pillars (16 and column 4, lines 46 – 68); and forming a metal layer (44) to contact said exposed top surfaces of said plated pillars (16) (column 2, line 66 – column 6, line 19).

Brighton et al. fail to expressly disclose wherein said polymer is selected to enable etching without the need for an etch barrier. However, this is inherent because Brighton et al. do not disclose using etch barrier layer to expose said plated pillars.

Brighton et al. fail to disclose wherein said dielectric material is a low dielectric polymer coated and cured on said one or more plated pillars and seed layer. However, Rhodes et al. (Figs.1-5) teach a method of forming a layered structure including the steps of forming a lower metal layer (2) on a surface of a substrate (4); forming an upper metal layer (8) on said lower metal layer (2); and forming on said lower metal layer (2) and said upper metal layer (8) a polyimide layer (12), wherein said forming further includes coating and curing said polyimide (12), wherein the metal layers are selected from the group including aluminum and copper (column 2, line 61 – column 3, line 50).

Furthermore, according to Wolf (Silicon Processing for the VLSI Era, Volume 2: Process Integration, pages 214 and 215) polyimides are well-known material used as planarizing interlevel dielectric layers because it can tolerate high temperatures without degradation, low dielectric constant and are free of pinholes and cracks.

Therefore, It would have been within the scope of one of ordinary skill in the art to combine the teachings of Brighton et al. and Rhodes et al. to enable forming the dielectric layer in Brighton et al. according to the teachings of Rhodes because one of ordinary skill in the art at the time the invention was made would have been motivated to look to alternative suitable methods of forming the dielectric layer of Brighton et al. and art recognized suitability for an intended purpose has been recognized to be motivation to combine. MPEP 2144.07.

The combined teachings of Brighton et al., Rhodes et al. and Wolf fail to teach wherein said coating step comprises coating with a low dielectric, non-planarizing

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polymer and forming a planarizing coating over said non-planarizing polymer. However, Lee et al. (Figs.1F and 2A) teach a method of forming a low-dielectric coating on a series of metal pillars (130), wherein in one embodiment of the invention includes coating with a low dielectric polymer (142) that can be planarized, and in a second embodiment of the invention includes coating with a low dielectric, non-planarizing polymer (242) and forming a planarizing coating (244) over said non-planarizing polymer (242) (column 4, line 63 – column 5, line 51).

It would have been within the scope of one of ordinary skill in the art to combine the teachings of Brighton et al., Rhodes et al. and Wolf with Lee et al. to enable the coating step of Brighton et al., Rhodes et al. and Wolf to be performed according to the teachings of Lee et al. because one of ordinary skill in the art at the time the invention was made would have been motivated to look to alternative suitable methods of performing the disclosed coating step of Brighton et al., Rhodes et al. and Wolf and art recognized suitability for an intended purpose has been recognized to be motivation to combine. MPEP 2144.07.

7. Claims 4 and 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Brighton et al. (U.S. 5,132,775) in view of Rhodes et al. (U.S. 4,536,951) and Wolf (Silicon Processing for the VLSI Era, Volume 2: Process Integration) as applied to claims 1 and 2 above, and further in view of Lin (U.S. 5,929,525).

The combined teachings of Brighton et al., Rhodes et al. and Wolf substantially teach all aspects of the invention but fail to disclose applying a dielectric layer over the lower and upper metal layer before said low dielectric polymer coating is applied,

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wherein said dielectric layer is selected from the group including silicon oxide.

However, Lin (Figs.1-9) teach a method of forming multilevel interconnects including the steps of providing a metal pillar (12) on a lower metal layer (9); and applying a silicon oxide layer (13) on the lower metal layer (9) and the metal pillar (12) (column 4, lines 19 – 44). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention made to enable forming the dielectric layer disclosed in Lin in the multilevel interconnect method of Brighton et al., Rhodes et al. and Wolf because this would provide passivation for the metal pillar structures (column 4, lines 19 – 44).

8. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Brighton et al. (U.S. 5,132,775) in view of Rhodes et al. (U.S. 4,536,951), Wolf (Silicon Processing for the VLSI Era, Volume 2: Process Integration) and Lin (U.S. 5,929,525) as applied to claims 1, 2, 4 and 5 above, and further in view of Tsai et al. (U.S. 5,252,515).

The combination of Brighton et al., Rhodes et al., Wolf and Lin teach applying a dielectric layer comprising silicon oxide (Lin, column 4, lines 19 – 44), but fail to disclose the dielectric layer comprising silicon nitride. However, Tsai et al. teach a method of forming an interconnect structure including the steps of forming a passivation layer (23); and coating said passivation layer (22, 23) with an SOG layer (24), wherein said passivation layer (23) is either silicon oxide or silicon nitride (Tsai et al., column 5, lines 1 – 49). It would have been within the scope of one of ordinary skill in the art to combine the teachings of Brighton et al., Rhodes et al., Wolf and Lin with Tsai et al. to enable forming the passivation layer of Brighton et al., Rhodes et al., Wolf and Lin using

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the materials according to the teachings of Tsai et al. because one of ordinary skill in the art at the time the invention was made would have been motivated to look to alternative suitable methods of forming the disclosed passivation layer of Brighton et al., Rhodes et al., Wolf and Lin and art recognized suitability for an intended purpose has been recognized to be motivation to combine. MPEP 2144.07.

9. Claims 7 and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Brighton et al. (U.S. 5,132,775) in view of Rhodes et al. (U.S. 4,536,951) and Wolf (Silicon Processing for the VLSI Era, Volume 2: Process Integration) as applied to claims 1 and 2 above, and further in view of Hendricks et al. (U.S. 6,153,525).

The combined teachings of Brighton et al., Rhodes et al. and Wolf substantially teach all aspects of the invention but fail to disclose wherein the step of coating comprises coating said one or more plated pillars and said lower metal layer with a silicon-based polymer. However, Hendricks et al. teach a method of forming a planarized dielectric layer by spin-on techniques, wherein said layer is selected from the group including polyimides, silicon-based polymers and benzocyclobutene (column 4, lines 13 – 20). It would have been within the scope of one of ordinary skill in the art to combine the teachings of Brighton et al., Rhodes et al. and Wolf with Hendricks et al. to enable forming the dielectric layer of Brighton et al., Rhodes et al. and Wolf according to the teachings of Hendricks et al. because one of ordinary skill in the art at the time the invention was made would have been motivated to look to alternative suitable methods of forming the disclosed dielectric layer of Brighton et al., Rhodes et al. and Wolf and art

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recognized suitability for an intended purpose has been recognized to be motivation to combine. MPEP 2144.07.

10. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Brighton et al. (U.S. 5,132,775) in view of Rhodes et al. (U.S. 4,536,951), Wolf (Silicon Processing for the VLSI Era, Volume 2: Process Integration) and Hendricks et al. (U.S. 6,153,525) as applied to claims 1, 2, 7 and 8 above, and further in view of the Applicants' Admitted Prior Art.

The combined teachings of Brighton et al., Rhodes et al., Wolf and Hendricks et al. substantially teach all aspects of the invention but fail to disclose coating the lower metal layer and the plated pillars with polynorbornene. However, the submitted prior art teaches wherein in practical applications, a polymer such as benzocyclobutene and polynorbornene, is known to be coated over a conventional dielectric, such as silicon dioxide or silicon nitride, on a wafer with metal layers and other topology formed thereon (page 1, [0003] – page 3, [0008]). It would have been within the scope of one of ordinary skill in the art to combine the teachings of Brighton et al., Rhodes et al., Wolf and Hendricks et al. with the prior art to enable the applying and coating step of Brighton et al., Rhodes et al., Wolf and Hendricks et al. to be performed according to the teachings of the prior art because one of ordinary skill in the art at the time the invention was made would have been motivated to look to alternative suitable methods of performing the disclosed coating step of Brighton et al., Rhodes et al. and Wolf and art recognized suitability for an intended purpose has been recognized to be motivation to combine. MPEP 2144.07.

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11. Claims 10 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Brighton et al. (U.S. 5,132,775) in view of Rhodes et al. (U.S. 4,536,951) and Wolf (Silicon Processing for the VLSI Era, Volume 2: Process Integration) as applied to claims 1 and 2 above, and further in view of Furukawa et al. (U.S. 6,387,783 B1).

The combined method of Brighton et al., Rhodes et al. and Wolf teach using a photoresist to form the plated pillars but fail to expressly teach using a photoresist with a re-entrant profile and using a negative i-line resist. However, Furukawa et al. (Figs.2A-2E) in a related method to pattern a metal layer teach using a photoresist (201) with a re-entrant profile and using a negative i-line resist (column 1, line 43 – 65). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to combine the teachings of Brighton et al., Rhodes et al. and Wolf with Furukawa et al. to enable using a photoresist as taught by Furukawa et al., since this would improve linewidth control in a multilayered stack (Furukawa et al., column 1, lines 25 – 33).

12. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Brighton et al. (U.S. 5,132,775) in view of Rhodes et al. (U.S. 4,536,951), Wolf (Silicon Processing for the VLSI Era, Volume 2: Process Integration) and Furukawa et al. (U.S. 6,387,783 B1) as applied to claims 1, 2, 10 and 11 above, and further in view of Samoto (U.S. 5,583,063).

The combined teachings of Brighton et al., Rhodes et al., Wolf and Furukawa et al. teach using a negative photoresist to define a pattern (Furukawa et al., column 1, line 43 – 65) but fail to expressly teach using a NH_3 image reversal of a photoresist.

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However, Samoto (Figs.2A-2H) is related to define a pattern for a semiconductor device teaches using a NH_3 image reversal of a photoresist (column 4, lines 18 – 36). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to use the photoresist of Samoto in the interconnect formation method of Brighton et al., Rhodes et al., Wolf and Furukawa et al., since this would allow the formation of defined small-sized patterns (column 2, lines 47-50).

Response to Arguments

13. Applicant's arguments filed 12/13/2006 have been fully considered but they are not persuasive.

Applicants argue, "...The Rhodes et al. patent is cited as disclosing a polymer coating, i.e., a polyimide coating. However, it is clear that the selection of the polyimide coating in the Rhodes et al. patent requires a barrier layer 6 to prevent over etching of the polyimide...". In response to this argument, Rhodes et al. do require barrier layer 6 to protect metal layer 2 from over etching, and not "to prevent over etching of the polyimide" as argued. Furthermore, Rhodes et al. do teach exposing pillars (10) without using an etch barrier (Rhodes et al., column 3, lines 51 – 68).

Conclusion

14. Applicants are encouraged, where appropriate, to check Patent Application Information Retrieval (PAIR) (<http://portal.uspto.gov/external/portal/pair>) which provides applicants direct secure access to their own patent application status information, as well as to general patent information publicly available.

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15. Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Julio J. Maldonado whose telephone number is (571) 272-1864. The examiner can normally be reached on Monday through Friday.

16. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith, can be reached on (571) 272-1907. The fax number for this group is 571-273-8300. Updates can be found at

<http://www.uspto.gov/web/info/2800.htm>.

Julio J. Maldonado
Patent Examiner
Art Unit 2823



Julio J. Maldonado
June 30, 2006



GEORGE R. FOURSON
PRIMARY EXAMINER